Kanmantoo Callington Community Consultative Committee (KCCCC) with Hillgrove Resources Limited and the Kanmantoo Copper Mine

SOURCES OF DUST

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Note from the Chair of the KCCCC

This Information Sheet has been put together by the Kanmantoo Callington Community Consultative Committee (KCCCC) from information given to it by Hillgrove Resources Limited and from observations made by the Dust Working Party as part of their role in 'assisting all stakeholders and the community to gain a comprehensive understanding of the mine's operations, rehabilitation, decommissioning and mine closure plans' (KCCCC Terms of Reference July 2014).

The information will be added to as new initiatives are developed at the mine.

Bob Goreing Independent Chair KCCCC April 2015

Disclaimer

The Information Sheet is based solely on materials provided to KCCCC by Hillgrove Resources Limited, information gathered by the KCCCC Dust Working Party during site visits to the Kanmantoo Copper Mine site and discussions with Hillgrove staff. These materials and information have not been checked for accuracy by the KCCCC and the KCCCC makes no representation, either expressly or implied, that the information displayed is accurate or fit for any particular purpose, and expressly disclaims all liability for loss or damage arising from reliance upon the information displayed.

30 April 2015

1. Mining and processing

Mining and processing at the Kanmantoo Copper Mine begins with finding and digging up copper ore in the ground and ends with producing a copper concentrate that is taken away in containers for export. The ore in the ground contains about 0.7% copper and copper concentrate at the end of the process contains about 23% copper.

Each of the steps along the way involves a number of activities. Some of these activities have more risk for producing dust than others.

Processes	**Activities**	**Likelihood of dust**[1]
Exploring for minerals	aerial survey drilling sampling	no medium medium
Extracting ore and rock from the mining pits	drilling blasting excavating	medium high high
Transporting and dumping rock, ore and other materials around the mine site	loading hauling dumping storing	high high high medium
Crushing and grinding the ore	loading crushing and grinding conveying stockpiling	high high low medium
Processing the finely ground ore	milling flotation scalping cleaning filtering concentrating	negligible negligible negligible negligible negligible negligible
Other parts of the mining lease	environmental plantings	low
Building and construction	hauling dumping building earthworks	high high high

2. Exploration drilling

Drilling on the mining lease is carried out for various reasons like preparing blast holes and mineral exploration.

Mineral exploration is an ongoing program of drilling and sampling across the mining lease so that the company can better understand the mineral deposits that it has already discovered and to try and find more. This exploration means that the company needs to clear small areas of land ready for drill rigs, dig and line water sumps (or tanks) and prepare tracks to allow the drilling equipment to be set up and supplied.

[1] assessment provided by Hillgrove Resources Limited

Managing dust

Water carried on water carts is used to control dust when the drilling sites are being set up.

Where drill cuttings and samples are stored in the open, they can be treated with a polymer which binds the soil particles and reduces the chances of dust being blown off these piles.

Sites are rehabilitated after the drilling is finished except where the drilling is used to prepare for blasting. This rehabilitation helps to reduce the potential for dust to be picked up by the wind in the future because the vegetation that returns to cover the site helps to hold the soil together.

Roc Drill drill rig

3. Blasting

Blasting causes a major disturbance to rock and has the potential to raise significant dust over a short period of time.

Managing dust

Getting ready to blast involves designing and marking out the blast site and then levelling and preparing the area using earth moving equipment.

Once the blast holes are drilled and filled with explosive, the area to be blasted is watered down. However much of the rock that will be disturbed by the blast is at depths of up to 15 metres below

the surface and cannot be treated with water to keep the dust down until it is exposed. Where there is a higher dust risk from blasting, for example when it is hot and dry, a water cart moves in to suppress dust by using a water cannon as soon as it is safe.

A watch is kept on weather conditions that may lift the dust away from the blast site. Wind speed and direction are considered along with other weather factors like humidity and temperature.

The three day weather forecast is used to identify the risk of dust escaping from blasting. The actual wind speed at the time of a blast is monitored on site with a wind sock.

An important part of managing dust from blasting involves having different levels of responsibility for authorising a blast depending on the risk of dust based on wind speed and direction.

There are three levels of authorisation. In general terms the higher the wind speed and the greater the likelihood that the wind direction may mean that dust could be blown towards nearby townships, the higher the authority required to continue, defer or cancel the blast. The General Manager of the mine must be present to authorise a blast when the risk from dust is at its highest.
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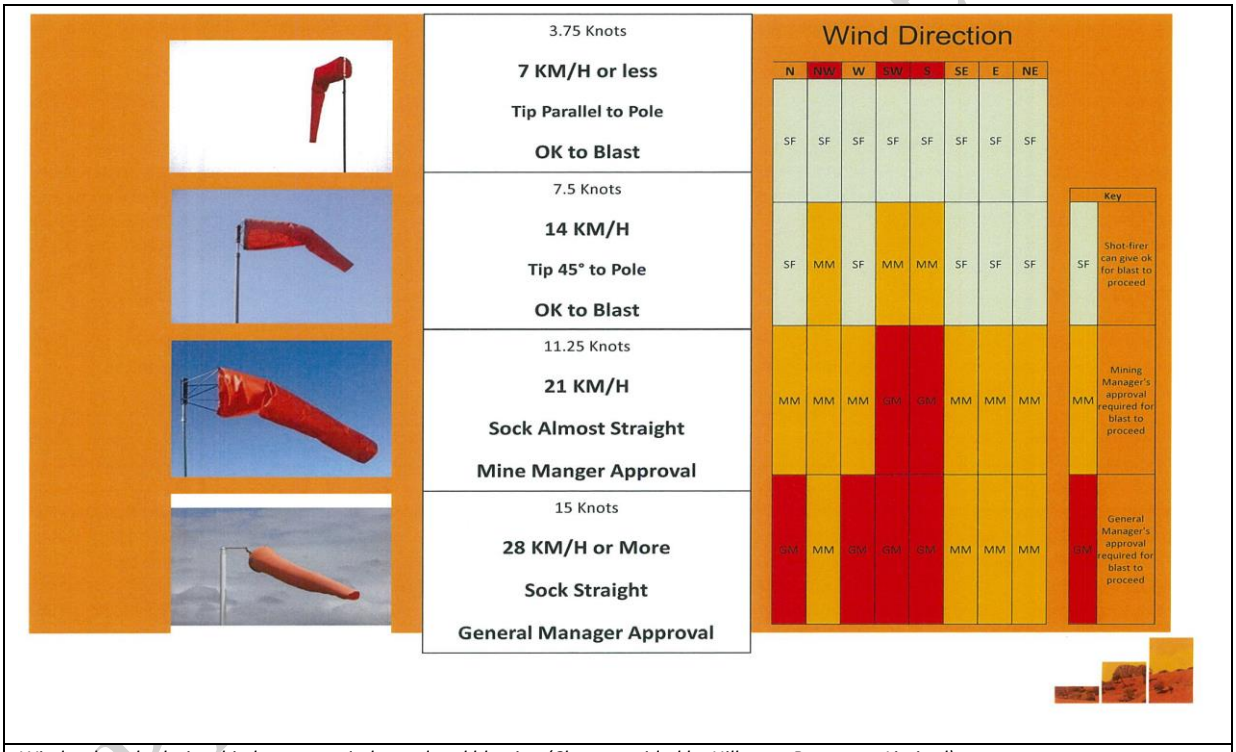


Windsock and relationship between wind speed and blasting (Chart provided by Hillgrove Resources Limited)

There is a difference in the risk of dust from blasting in different parts of a pit. For example if a blast is near the top of a pit like when a new pit is being opened up, the risk of dust escaping into the air and being blown off the mine site is much greater than if a blast is near the bottom of a deep pit.

The soil near the top of the pit also often contains more fine material than the hard rock in the bottom which makes the likelihood of dust greater. The mine has a Dust Response Plan that takes these factors into account.

The company lets the community know when to expect a blast. They advertise the blast times on the Hillgrove website and also send a message to a data base of interested community members via mobile phone.

An area of work near the rim of a new pit can be seen in the background

Preparing for blasting near the rim of a satellite pit

Blasting in the main pit (photo courtesy of Hillgrove)

4. Loading and hauling

One of the most likely activities to raise dust on the mine site is the continuous coming and going of the 17 haul trucks. These are loaded by excavators in the pit and move along the haul roads to the ore stockpile (known as the Run of Mine (ROM)) or the waste rock dump where they tip their loads.

Loading a haul truck with ore

Hauling ore along a haul road

Managing dust

The mine has three water carts with sizes ranging from 30,000 Litres (L) to 100,000L. These water carts are rostered to work continuously. They have a special focus on the high risk time of the day which goes from daybreak to about 10 pm and when there are high winds and low humidity. Again the risk is worked out by looking at weather conditions.

The water carts are filled by a high-pressure, high-flow water pump that takes about 10 – 12 minutes to fill the smaller 30,000L cart. This quick filling time means that the three water carts can do an average of 25 - 26 separate trips per day. On peak days there can be more than 40 trips.

An average of 1.3 million litres of water per day is used to keep dust down across the whole year. This water comes mainly from the waste water that the company buys from the District Council of Mt Barker.

The water cart operators wet down the haul roads just enough so that dust is kept down but the road remains safe and not slippery for the trucks.

The water cart operators use a 'hot seat' for shift changeovers where a loaded truck is passed over to the next driver to carry on where the previous shift left off. This is important because shift change is a time when there is likely to be high traffic movement into and out of the site and therefore the potential to generate dust from this traffic.

High volume and fast rate pumps used to fill water carts

Water carts

Filling a water cart from the stand pipe

5. Crushing ore

Ore is stored on a stockpile ready to be fed into the crusher where it will be broken down into smaller pieces. The stockpile of ore is called the Run of Mine (ROM) stockpile because it keeps the crushing and the processing cycle of the operation supplied with ore even if mining stops because it is too wet or too hot or for some other reason.

The ore is picked up from the ROM by a large rubber wheel loader that drops it into a 200 tonne feed bin called the Hopper.

At the bottom of the Hopper there are vibrating bars designed to let the smaller material (less than 100 millimetres (mm) in diameter) go through while they trap the larger rock. The larger rock is vibrated into the primary crusher which is a 'jaw' crusher that crushes it to a size less that 125 mm in diameter.

The crushed larger rock and the smaller material that was separated earlier are moved along a conveyor to a screen (or a sieve) that separates even finer material (less than 25mm in diameter) from the rest.

The fine material is sent directly to a stockpile of crushed material called the Coarse Ore Stockpile (COS). The larger rocks are sent on to another crusher (the secondary crusher or 'cone' crusher) before they reach the COS by conveyor.

Dust management

There are several places is this crushing cycle where there is an increased risk of dust escaping. These include the loading and dumping of the ore from the ROM stockpile into the Hopper, the smaller material being separated by falling through the vibrating bars, the primary crushing of larger rock in the 'jaw' crusher and the crushing of rock in the secondary crusher.

Dust that could escape from the storing and loading of the ore on the ROM stockpile is kept down by watering the stockpile using a 'fogger'. The fogger is a fixed water cannon with a nozzle that breaks down the size of the water droplets into a coarse mist.

The Hopper is designed as a three sided shed to provide protection from the wind. There are water jets at the top of the Hopper to reduce the dust that may be given off as the ore is dropped in.

The Hopper which leads to the primary crusher, enclosed on three sides and fitted with overhead water misting jets

A dust extractor using vacuum processes has been fitted alongside the Hopper to catch dust escaping from the jaw crusher. The dust extractor is effective for controlling dust emissions but it has needed considerable development by the company to deal with issues related to the properties of the ore at Kanmantoo.

The Kanmantoo ore is made up of a Garnet Adalucite Biotite Schist. This ore is particularly hard on the metal parts of the dust extractor and the company has needed to try a number of different designs and materials to keep it running longer between servicing.

Dust extractor fitted to the base of the crusher feed bin

Rock moving through the crushers

6. Conveying crushed materials and storing material on stockpiles

Conveyors are used to move crushed rock between the crushers and the COS and on to the grinding mill. It is possible that dust can escape during this stage especially where this material is passed from one area to another like being dropped onto the COS.

Dust management

Parts of the conveyor system are covered like the part leaving the Hopper but generally they are open. Once on the conveyor the crushed rock is relatively stable with a fairly low profile. This reduces the likelihood of dust escaping.

Covered and open conveyors carry materials around the processing facility

On most mines sites, crushed rock in the COS is stockpiled in the open. Where this happens techniques are used like designing the angle of the slope (batter) to minimise the likelihood of dust escaping. As a rule the higher the stockpile and steeper the slope of the pile, the less dust is generated per volume of stored material. It is also important to put the COS in a place that is protected from the wind to reduce the potential for dust.

At the Kanmantoo Copper Mine and at many other recent mines, the crushed rock is stored in a 'shed' with a covered roof and flexible sides to let equipment get in and out but minimise the potential for dust to escape.

Coarse Ore Stockpile (COS)

There are also other places on the mining lease where stockpiles of materials like top soil are at risk of releasing dust. The company has trialled a binding product (polymer) that can be sprayed on to some of these sites to hold any fine material together and reduce dust. The polymer appears to have worked effectively on the stockpiles but not so well on areas that carry heavy traffic. For these areas the company has trialled a range of products and the most successful is a product known as Dust-a-Side. Similar to the other polymers, the Dust-a-Side product binds the fine particles into larger clumps that are less likely to raise dust.

Spaying polymer binder onto roads and roadside edges (photo courtesy of Hillgrove Resources Limited)

7. Processing, storing, handling and transporting final product

The stored crushed material on the COS is conveyed to a semi autogenous grinding (SAG) mill where it is ground to a very fine material which is about 0.2 mm in diameter. It is mixed with water. The next stages of processing are done in tanks with the material carried as a fluid. This means that it is not likely to generate dust.

SAG Mill

Float cells in the processing facility. The processing of the crushed ore to produce the concentrate for sale is a 'wet process'

The final product from the processing of the ore is a copper concentrate. The concentrate is filtered and taken by covered conveyer into a shed with a concrete floor. The concentrate contains approximately 23% copper. This is the final product and it also contains about 7% water. It looks like a grey, fine grained powder.

Over 90% of the water used in the processing of the ore is recirculated and reused. The rest is lost to evaporation, left in the final product or trapped in the tailings. The tailings are the non valuable part of the material that was put through the processing cycle.

The concentrate (final product) is stored in a closed shed

Dust management

Producing the final product from the crushed ore is a 'wet' process. This means that water and other liquids are added and there is therefore a negligible risk of dust being produced during this process.

The final product is loaded into containers inside the storage shed. The containers are covered with a sealed lid. These are then transported by semi-trailers to Flinders Ports in Port Adelaide.

Once a ship arrives, the containers are lifted using a crane fitted with a special device that lowers the containers into the ship's hold, lifts the lid and tips out the concentrate. This process is designed to reduce the likelihood of dust escaping.

The final product is then shipped to a smelting refinery with all shipments so far exported to China.

8. Traffic movements

Keeping dust down on the mine site is the responsibility of the company. However there is a lot of traffic that comes and goes from the mine site that the company has no direct responsibility for apart from advising and implementing on-site rules related to speed and other behaviour. This traffic can lift dust particularly on unsealed roads.

Transport delivering supplies and taking the final product to the port as well as visitors to the site are examples of this type of traffic.

Dust management

The mine has developed a dedicated haul road on private property leading to the Old Princes Highway. This road is maintained by the company. Speed can be limited by signposting and water is used to keep dust down. Suppliers to the mine are asked to use this service road.

Final product is transported to Port Adelaide for shipping in sealed containers

The Dust- a-side polymer binder gives the road surface a darker brown colouration.

Hillgrove's dedicated service road linking the mine site with Old Princes Highwa.

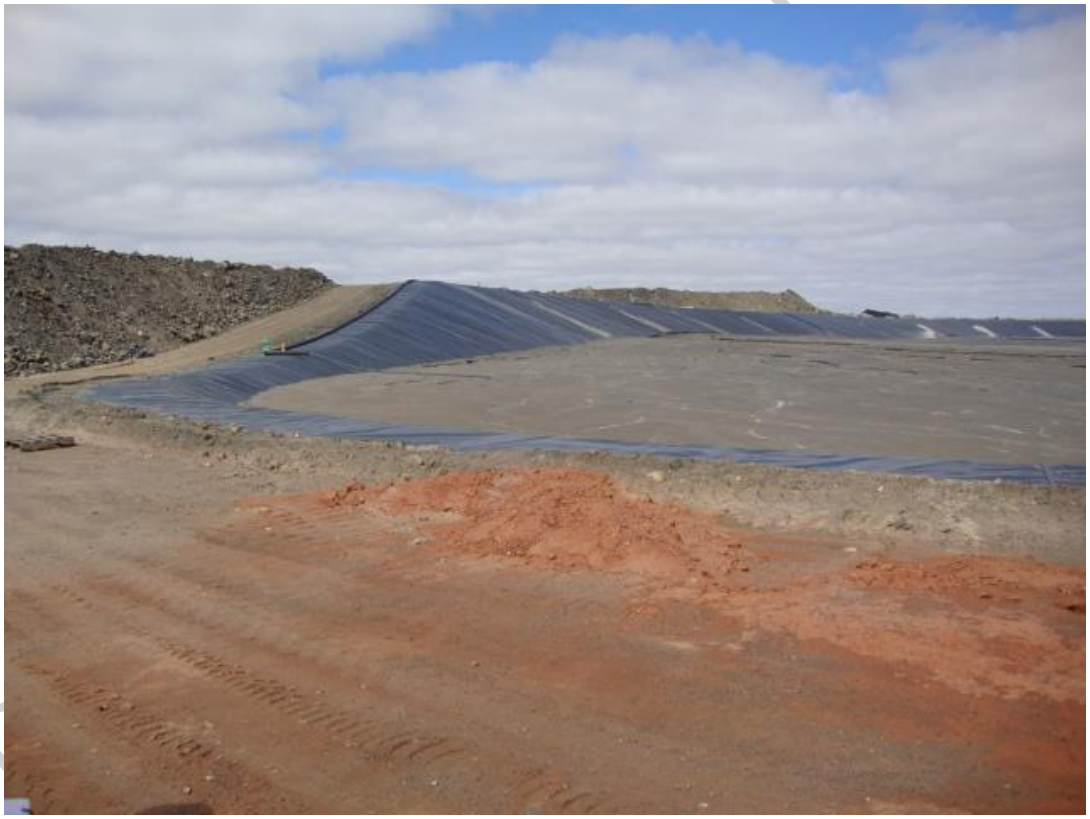
9. Building and construction

Facilities at the mine are not all needed at once. They are built or extended as they are needed. The approval to build these facilities is granted with the original application for a mining lease and details are contained in the mine plan (Program for Environmental Protection and Rehabilitation (PEPR)).

An example of this is the Tailings Storage Facility (TSF) which has been built in stages. This involves building containment walls where special dirt is brought onto the site and dumped. This material is important because it helps to hold water inside the dam like clay soils hold water better than sandy soils. Trucking in these materials, dumping them and then pushing them around to shape up the walls has the potential to raise dust.

The tailings themselves are waste materials left over from minerals processing. They are mainly finely ground rock minus the copper that has been extracted.

The tailings are wet and can be pumped through a pipeline. The pipeline leads to the TSF where spigots or 'take off pipes' carry them down the walls of the dam. It is important to carry the tailings down to the level of the tailings already in the dam otherwise they could dry out on the plastic liner covering the dam walls and be blown away.



TSF under construction

Managing dust

Facilities like the TSF are built as individual projects rather than as part of the day to day operations of the mine. This means that the project team can focus on the particular risks like dust that may relate to each project and design special solutions that match these unique risks.

In the case of the TSF, the company uses water carried in water tankers to keep the dust down on the roads used by trucks and other equipment. The water tanker operators are told the schedule of truck movements so that they can be ready.

As the building gets to points where there may be more trucks coming and going, the company can let the community know and focus on reducing the risk of dust. It can also look for weather conditions like high wind speed, dry conditions or the potential for a temperature inversion over the area, and take these into account.

There is the potential for dust to be raised from tailings that are left to dry on the plastic liner that covers the walls of the TSF. To reduce this potential the spigots that run down the walls and into the tailings dam are often moved around the wall. This changes the spot where the watery waste runs out and reduces the likelihood of tailings drying out on the plastic liner and blowing away.

The bottom of the spigots are fitted with deflectors to spray the wet tailings away from the wall and to prevent channels of dried material being gouged out where the wet tailings are deposited. This also helps to reduce the potential for dust to be blown off as the tailings dry out.

TSF showing liner, pipeline and spigots that are moved around to reduce likelihood of dust from tailings drying out

10. Other parts of the mining lease

Only a small proportion of the mining lease is mined. The approval to mine includes a program to conserve some areas of the mining lease for biodiversity and other environmental purposes and a requirement to develop some areas as an offset to the clearance of vegetation on other parts of the mine site.

Managing dust

There is the potential for dust to be blown off areas of the mining lease that are not currently being mined particularly if these have been cleared during some previous land use. As well as providing biodiversity and conservation benefits, good environmental management of the mining lease can help to manage dust.

Areas can be planted with native vegetation to bind the soil and catch dust. These areas can take into account the direction of the prevailing winds to screen nearby residents.

The chance of getting strong growth in these planting programs can be increased by linking them up with existing areas of vegetation.

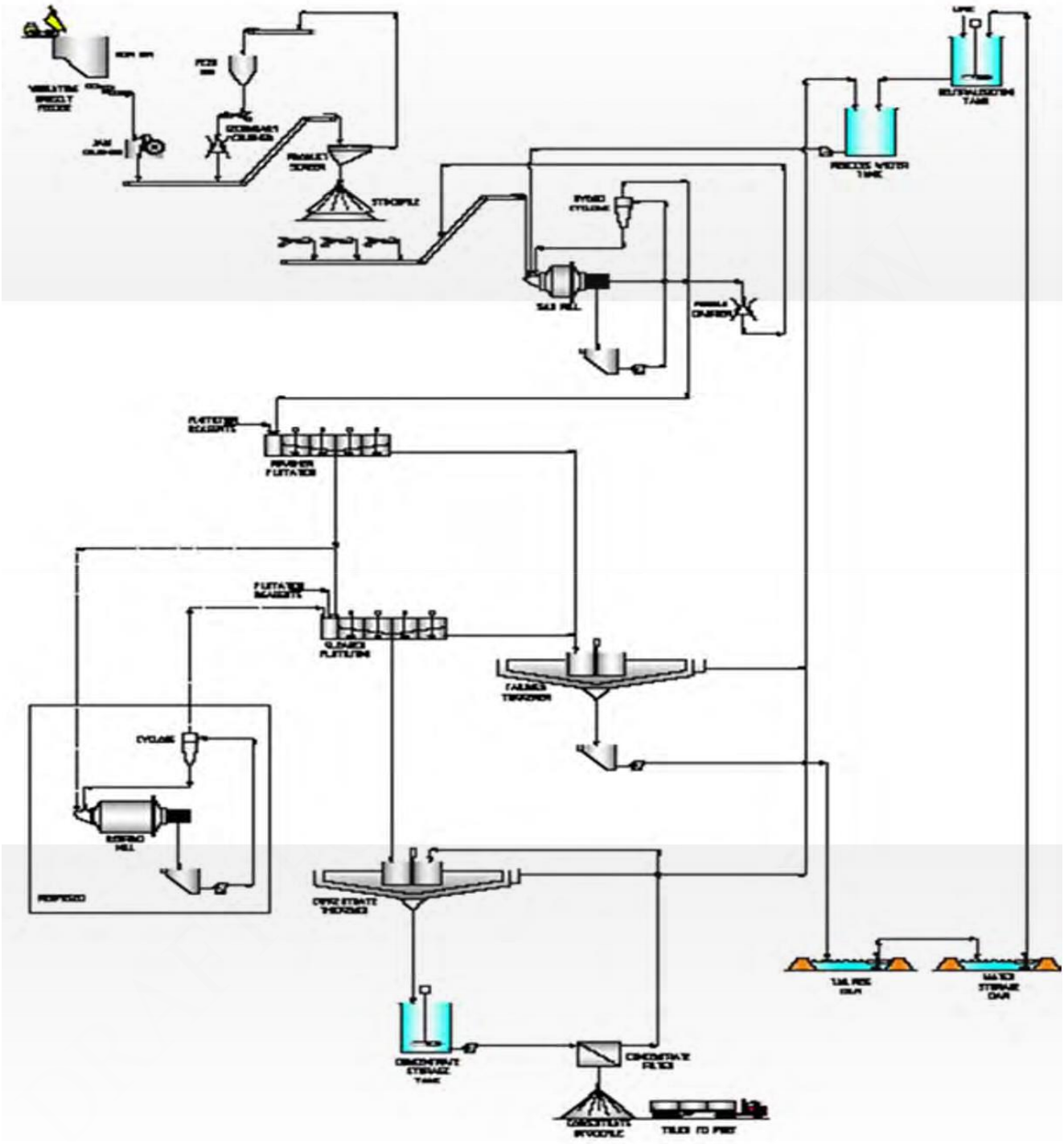
The local Kanmantoo Callington Landcare group has been very helpful in this work and the company has supported this approach with the establishment of a seed banking and propagation centre on site. The community has also helped to identify particular biological communities and locations like the Eucalyptus Odorata to the north of the main pit that should be priorities for conservation.

Seed propagation site

Rehabilitation areas

A case study showing rehabilitation in the Woodland in the North West area of the Mining Lease has been developed and is available separately.

Appendix 1: The mining and processing circuit



Acronyms

No	acronym	meaning	notes
1	COS	Coarse Ore Stockpile	The stockpile of crushed ore that is assembled for feeding into the processing cycle
2	KCCCC	Kanmantoo Callington Community Consultative Committee	
3	L	Litres	volume of liquid
4	mm	millimetres	length (1000 millimetres equals a metre)
6	MARP	Mining and Rehabilitation Plan	
7	PEPR	Program for Environment Protection and Rehabilitation	The modern name for the mine plan (MARP)
8	ROM	Run of Mine stockpile	The stockpile of ore that has been mined and is assembled for feeding into the crushing cycle
9	SAG	Semi Autogenous Grinding mill	The SAG Mills uses metal grinding balls and a tumbling motion to grind the ore into small particles
10	TSF	Tailings Storage Facility	

Acknowledgements

Photographs and other images

Photographs have been taken by the Dust Working Party except where shown otherwise.

The images have been chosen to show various facilities and processes. It is acknowledged that similar photographs taken on days with different weather conditions may show more or less dust arising. To be clear, the photographs should not be seen as illustrations of particular dust levels generated by each facility or process but rather as a guide to the various methods used to suppress dust.

<u>For more information about Sources of Dust contact:</u>

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